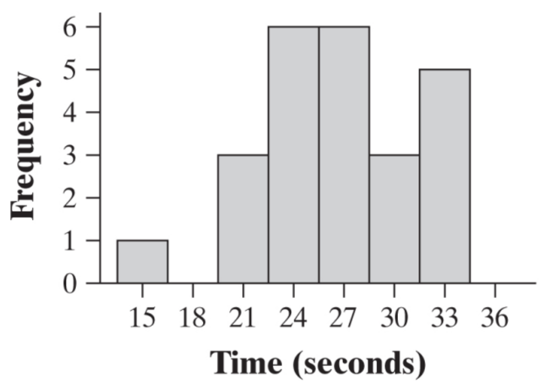
Chapter Review Exercises (page 604)

R9.1 (a) $H_0: \mu = 64.2; H_a: \mu \neq 64.2$ where μ = the true mean height of this year's female graduates from the local high school.
(b) $H_0: p = 0.75$; $H_a: p < 0.75$ where p = the true proportion of all students at Mr. Starnes' school who completed their math homework last night.

R9.2 Random: The adults were chosen at random. 10%: The sample size (24) is less than 10% of the population of adults. Normal/Large Sample: Because the sample size is small, we need to graph the sample data. The histogram below shows that the distribution is roughly symmetric with no outliers, so using a *t* procedure is appropriate.



R9.3 (a) $H_0: \mu = 300$ versus $H_a: \mu < 300$ where μ = the true mean breaking strength of these chairs.
(b) A Type I error would be finding convincing evidence that the mean breaking strength is less than 300 pounds, when in reality it is 300 pounds or higher. The consequence of a Type I error is falsely accusing the company of lying. A Type II error would be not finding convincing evidence that the mean breaking strength is less than 300 pounds, when in reality it is less than 300 pounds. The consequence of a Type II error is allowing the company to continue to sell chairs that don't work as well as advertised.
(c) Because a Type II error is more serious, we would like to reduce its probability. This means increasing the probability of a Type I error by using a significance level of α = 0.10.
(d) If the true mean breaking strength is 294 pounds, there is a 0.71 probability that we will find convincing evidence that the true mean breaking strength is less than 300 pounds.
(e) To increase the power of the test, we can either increase the sample size *n* or increase the significance level α .

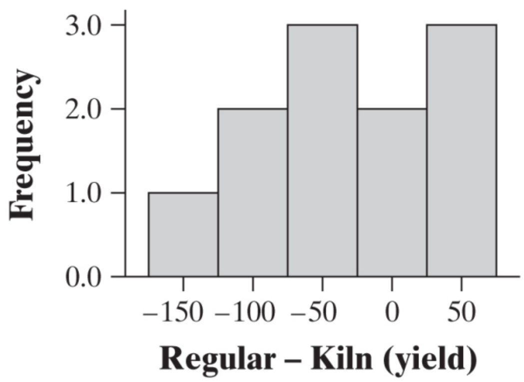
R9.4 (a) *State*: We want to perform a test of $H_0: p = 0.05$ versus $H_a: p < 0.05$ where *p* is the true proportion of adults who will get the flu after using the vaccine. We will use $\alpha = 0.05$. *Plan*: If conditions are met, we should do a one-sample *z* test for the population proportion *p*. Random: The sample was randomly selected. 10%: The sample size (1000) is less than 10% of the population of adults. Large Counts: $np_0 = 1000(0.05) = 50 \geq 10$ and $n(1-p_0) = 1000(0.95) = 950 \geq 10$. *Do*: The sample proportion is $\hat{p} = \frac{43}{1000} = 0.043$. The corresponding test statistic is $z = \frac{0.043 - 0.05}{\sqrt{\frac{0.05(0.95)}{1000}}} = -1.02$ and the *P*-value is $P(Z \leq -1.02) = 0.1539$. *Conclude*: Because the *P*-value of 0.1539 is greater than α = 0.05, we fail to reject H_0. We do not have convincing evidence that fewer than 5% of adults who receive this vaccine will get the flu.
(b) Because we failed to reject the null hypothesis, we could have made a Type II error—not finding convincing evidence that the true proportion of adults who get the flu after using this vaccine is less than 0.05, when in reality the true proportion is less than 0.05.
(c) Answers will vary. The consequence of a Type I error is that the company might get sued for false advertisement. The consequence of a Type II error is loss of potential income.

R9.5 (a) Assuming that the roulette wheel is fair, there is a 0.0384 probability that we would get a sample proportion of reds at least this different from the expected proportion of reds (18/38) by chance alone.
(b) Because the *P*-value of 0.0384 is less than α = 0.05, the results are statistically significant at the α = 0.05 level. This means that we reject H_0 and have convincing evidence that the true proportion of reds is different than *p* = 18/38. In other words, there is convincing evidence that the wheel is unfair.
(c) Because 18/38 = 0.474 is one of the plausible values in the interval, this interval does not provide convincing evidence that the wheel is unfair. It does not, however, prove that the wheel is fair as there are many other plausible values in the interval that are not equal to 18/38. Also, the conclusion here is inconsistent with the conclusion in (b) because the manager used a 99% confidence interval, which is equivalent to a test using α = 0.01. If the manager had used a 95% confidence interval, 18/38 would not be considered a plausible value.

R9.6 (a) *State:* We want to perform a test of $H_0: \mu = 105$ versus $H_a: \mu \neq 105$ where μ is the true mean reading from radon detectors. We will perform the test at the $\alpha = 0.10$ significance level. *Plan*: If conditions are met, we should do a one-sample *t* test for the population mean μ. Random: The radon detectors were chosen at random. 10%: The sample size (11) is less than 10% of all radon detectors. Normal/Large Sample: The sample size is small, but a graph of the data shows no strong skewness or outliers so using a *t* procedure is appropriate. *Do*: The test statistic is $t = \frac{104.82 - 105}{9.54/\sqrt{11}} = -0.06$. With df = 11 – 1 = 10, *P*-value > 2(0.25) = 0.50. *Using technology*: *P*-value = 0.9513. *Conclude*: Because the *P*-value of 0.9513 is greater than α = 0.10, we fail to reject H_0. We do not have convincing evidence that the true mean reading from the radon detectors is different than 105. In other words, we do not have convincing evidence that the radon detectors are inaccurate.

(b) Yes. Because 105 is in the interval from 99.61 to 110.03, both the confidence interval and the significance test agree that 105 is a plausible value for the true mean reading from the radon detectors.

R9.7 (a) The random condition can be satisfied by randomly allocating which plot got the regular barley seeds and which one got the kiln-dried seeds within each pair of adjacent plots.
(b) *State:* We want to perform a test of $H_0: \mu_d = 0$ versus $H_a: \mu_d < 0$ where μ_d is the true mean difference (regular – kiln) in yield between regular barley seeds and kiln-dried barley seeds. We will perform the test at the $\alpha = 0.05$ significance level. *Plan*: If conditions are met, we should do a paired *t* test for μ_d. Random: We assume that the treatments were randomly assigned to the two plots in each adjacent pair. Normal/Large Sample: Because the number of differences is small, we need to graph the observed differences. The histogram below shows no strong skewness or outliers, so it is appropriate to use a *t* procedure.



Do: The sample mean and standard deviation are: $\bar{x} = -33.7$ and $s_x = 66.2$. The corresponding test statistic is $t = \dfrac{-33.7 - 0}{66.2/\sqrt{11}} = -1.690$. With df = 11 – 1 = 10, the *P*-value is between 0.05 and 0.10. *Using technology*: *P*-value = 0.0609. *Conclude*: Because the *P*-value of 0.0609 is greater than $\alpha = 0.05$, we fail to reject H_0. We do not have convincing evidence that the true mean difference (regular – kiln) in yield is less than 0. In other words, we do not have convincing evidence that kiln-dried barley seeds produce a larger yield than the regular barley seeds, on average.